CLAIMS

What is claimed is:

1. A polyolefin production system, comprising:

a polymerization reactor; and

a temperature control system configured to control the temperature of a reaction mixture within the polymerization reactor, wherein the temperature control system comprises a temperature control valve having a bilinear flow characteristic disposed in a conduit of the temperature control system.

2. The polyolefin production system as recited in claim 1, wherein a transition region where the bilinear flow characteristic changes slope corresponds to a coolant condition for a polyolefin grade having the least demanding cooling requirement of the polymerization reactor product mix at or below design production turndown of the polymerization reactor.

3. The polyolefin production system as recited in claim 2, wherein the polymerization reactor is a polyethylene reactor.

4. The polyolefin production system as recited in claim 2, wherein the coolant condition generally corresponds to 75% of normal production rate of the polyolefin grade having the least demanding cooling requirement.

5. The polyolefin production system as recited in claim 1, wherein the bilinear flow characteristic changes slope at less than 50% open position of the temperature control valve.

6. The polyolefin production system as recited in claim 1, wherein the bilinear flow characteristic is derived from a simulation model.

7. The polyolefin production system as recited in claim 1, wherein the temperature control system comprises one or more controllers configured to operate the temperature control valve.

8. The polyolefin production system as recited in claim 7, wherein one or more tuning constants of the one or more controllers are derived from a dynamic simulation model.

9. The polyolefin production system as recited in claim 1, wherein a calculation block that defines the output of a slave controller configured to operate the temperature control valve is derived from a simulation model.

10. The polyolefin production system as recited in claim 9, wherein the slave controller is configured to operate more than one temperature control valve.

11. The polyolefin production system as recited in claim 1, wherein the polymerization reactor comprises a loop slurry reactor configured to react at least one or more monomers and one or more catalysts to form a polymer.

12. The polyolefin production system as recited in claim 1, wherein the polymerization reactor comprises at least one of a motive device, a reactant inlet, a catalyst inlet, a diluent inlet, and a polymer slurry outlet.

13. The polyolefin production system as recited in claim 1, wherein the temperature control system comprises:

one or more reactor jackets configured to thermally interface with the polymerization reactor and to allow circulation of a liquid within the reactor jackets;

one or more heat exchangers configured to remove heat from the liquid;

one or more pumps configured to circulate the liquid through the one or more reactor jackets and the one or more heat exchangers; and

a plurality of conduits connecting at least the one or more reactor jackets, the one or more heat exchangers, and the one or more pumps.

14. A temperature control system for a polyolefin production system, the system comprising:

a coolant system configured to remove heat from a polymerization reactor; and

a temperature control valve having a bilinear flow characteristic disposed in a conduit of the coolant system.

15. The temperature control system as recited in claim 14, wherein a slope transition region of the flow characteristic corresponds to a start-up coolant condition for a polyolefin grade of a site product mix which causes the undesirable Cv reproducibility for the temperature control valve.

16. The temperature control system as recited in claim 15, wherein the polyolefin grade is a polyethylene grade.

17. The temperature control system as recited in claim 15, wherein the start-up coolant condition is defined as 75% of design production rate for the polyolefin grade.

18. The temperature control system as recited in claim 14, wherein the bilinear flow characteristic changes slope at less than 50% open position of the temperature control valve.

19. The temperature control system as recited in claim 14, wherein the bilinear flow characteristic is derived from a simulation model.

20. The temperature control system as recited in claim 14, wherein the temperature control system comprises one or more controllers configured to operate the temperature control valve.

21. The temperature control system as recited in claim 20, wherein one or more tuning constants of the one or more controllers are derived from a dynamic simulation model.

22. The temperature control system as recited in claim 14, wherein a calculation block that defines the output of a slave controller configured to operate the temperature control valve is derived from a simulation model.

23. The temperature control system as recited in claim 14, wherein the coolant system comprises:

one or more reactor jackets configured to thermally interface with one or more respective polymerization reactor components and to circulate a liquid;

one or more heat exchangers configured to remove heat from the liquid;

one or more pumps configured to pump the liquid through the one or more reactor jackets and the one or more heat exchangers;

a plurality of conduits connecting at least the one or more reactor jackets, the one or more heat exchangers, and the one or more pumps.

24. The temperature control system as recited in claim 14, wherein the polymerization reactor comprises a loop slurry reactor.

25. A valve, comprising:

a body comprising a port with a seat; and

a valve stem comprising a plug disposed on one end of the stem, wherein the stem is moveable between a fully closed position and a fully open position such that the plug substantially seals against the seat in the fully closed position;

wherein the valve has a bilinear inherent flow characteristic having a transition region at or below a 50% open valve position, such that, from the fully closed position to the transition region, the valve has a first linear flow characteristic at a first slope and, from the transition region to the fully open position, the valve has a second linear flow character at a second slope greater than the first slope.

26. The valve as recited in claim 25, wherein the first and the second slope may be measured as Cv / % open.

27. The valve as recited in claim 25, wherein the transition region corresponds to the percent open of a cooler control valve in a start-up coolant condition for polymerization in a polyolefin reactor of a polyethylene grade that requires the least cooling capacity of the reactor product mix at or below a polyolefin plant design turndown requirements.

28. A model for simulating temperature control of a polyolefin polymerization reactor, the model comprising:

a reactor component configured to dynamically represent at least a temperature in a polymerization reactor and a heat transfer capability from the polymerization reactor to a coolant based on one or more reaction conditions and one or more temperature control system outputs; and

a temperature control system component configured to dynamically generate the one or more temperature control system outputs in response to the one or more reaction conditions and one or more temperature control system inputs.

29. The model as recited in claim 28, wherein the reaction conditions comprise at least one of a polyolefin production rate, a polyolefin heat of polymerization, a polyolefin product grade, and a reactor slurry density.

30. The model as recited in claim 28, wherein the one or more temperature control system outputs comprise at least one of a coolant supply temperature, coolant circulation rate, and coolant return temperature.

31. The model as recited in claim 28, wherein the one or more temperature control system inputs include at least one of a desired reactor temperature, a cooling tower water temperature, a sea water temperature, a cooler heat transfer coefficient correlation, a cooler pressure drop profile, a cooler heat transfer area, and a reactor jacket heat transfer area.

32. The model as recited in claim 28, wherein the coolant circulates through one or more reactor jackets and the model dynamically simulates heat transfer capability of the reactor jackets.

33. The model as recited in claim 32, wherein the heat transfer capability is a function of at least one of a surface area of the one or more reactor jackets and a dynamically simulated heat transfer coefficient of the one or more reactor jackets.

34. The model as recited in claim 33, wherein the heat transfer coefficient is a function of at least a reactor-side film coefficient and a jacket-side film coefficient.

35. The model as recited in claim 28, wherein outputs of the model are at least one of one or more controller tuning constants, one or more control valve flow characteristics, one or more controller output calculation blocks, and an actual reactor temperature.

36. The model as recited in claim 28, wherein the polymerization reactor comprises a polyethylene reactor.

37. A method for designing a temperature control system, the method comprising the acts of:

constructing a model of an interaction of a temperature control system and a polymerization reactor;

simulating two or more reactor thermal conditions in a range of interest using the model to generate one or more dynamic simulation outputs; and

modifying the model of the temperature control system and polymerization reactor based on the one or more dynamic simulation outputs such that one or more components of the temperature control system are configured to maintain a desired reactor temperature range.

38. The method of claim 37, wherein the one or more components comprise at least one of a temperature control valve, a reactor temperature controller, and a coolant temperature controller.

39. The method of claim 38, wherein modifying the model comprises at least one of modifying a flow characteristic of the temperature control valve, modifying a definition of the coolant controller output, and modifying one or more tuning constants of at least one of the reactor controller and coolant controller.

40. The model as recited in claim 37, wherein the polymerization reactor comprises a polyethylene reactor.

41. A method for controlling the temperature of a liquid in a temperature control system, comprising the acts of:

circulating a liquid through a coolant system; and

adjusting one or more temperature control valves having a bilinear flow characteristic to control the flow of the liquid through one or more heat exchangers.

42. The method of claim 41, wherein the coolant system comprises one or more temperature control jackets, one or more heat exchangers, and one or more pumps, connected by a plurality of interconnecting conduits.

43. The method of claim 41, comprising adjusting one or more control valves disposed in a cooler bypass conduit to maintain a constant liquid flow rate through the coolant system.

44. A method for designing a temperature control valve, comprising:

constructing a model of the interaction of a temperature control system and a polymerization reactor;

running steady state simulations of different operating conditions using the model to determine at least one of a coolant flow and a change in coolant pressure for each steady state simulation;

generating a Cv curve for a temperature control valve based upon the at least one of the coolant flow and the change in coolant pressure;

repeating the acts of constructing, running, and generating a Cv curve until the Cv curves substantially converge on a final Cv curve; and

designing a temperature control valve having an inherent flow character consistent with the final Cv curve.

45. A method for producing a temperature control valve, comprising:

producing a valve trim of a valve based on a desired Cv characteristic for the machined valve;

comparing the Cv characteristic of the valve with the desired Cv characteristic; and

repeating the acts of producing and comparing until the Cv characteristic of the valve substantially equals the desired Cv characteristic.

46. A method for determining controller tuning constants for a temperature control valve, comprising:

constructing a model of the interaction of a temperature control system and a polymerization reactor;

running steady state simulations to derive one or more system performance curves; and

running one or more dynamic simulations using the model and the one or more system performance curves to generate one or more controller tuning constants, wherein the one or more dynamic simulations simulate a change from a first temperature of the polymerization reactor to a second temperature over a time interval.